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Association of lung function with coronary heart disease and cardiovascular disease outcomes in elderly: The Rancho Bernardo study

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Summary
Introduction: Lung function is inversely associated with coronary heart disease (CHD) and cardiovascular disease (CVD). We evaluated the prospective association of reduced lung function by spirometry and CHD or CVD events in older community-dwelling adults.
Methods: We studied 1548 participants (mean age 73.6 ± 9.2 years, 42% males) from the Rancho Bernardo Study using age, sex, and risk-factor adjusted Cox regression to assess pulmonary function (FEV_1, FVC, and FEV_1/FVC ratio) as a predictor of CHD and CVD events followed for up to 22 years.
Results: Of CVD risk factors, older age, male sex, current/past smoking, physical exercise (<3× a week), and prevalent CVD predicted an increased risk of CHD and CVD. Higher FEV_1 and FVC were each associated with a decreased risk of CHD [HR 0.80 (0.73–0.88) for both FEV_1 and FVC, per SD, $p < 0.01$] and CVD [HR 0.82 (0.74–0.91) for both FEV_1 and FVC, per SD, $p < 0.01$]. Those in the lowest quartiles of FEV_1 and FVC had hazard ratios of 1.68 (1.33–2.13) and 1.55 (1.21–2.00) respectively for CHD and 1.74 (1.34–2.25) and 1.49 (1.13–1.96) respectively for CVD (all $p < 0.01$, relative to those in the highest quartile). Similar findings were observed for CHD and CVD mortality. Sex- and age-stratified analyses showed the strongest associations for CHD and CVD events in women and in the oldest participants.

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Conclusions: FEV_1 and FVC are inversely associated with risk of future CHD and CVD events in older community-dwelling adults and may add to CVD risk stratification in the elderly.

Introduction

In spite of the current evidence-based approaches to cardiovascular disease (CVD) reduction, CVD and coronary heart disease (CHD) remain the leading cause of mortality in many industrialized countries. Previous epidemiological studies have shown reduced lung function is a significant predictor of CHD and CVD mortality [1—3], as well as with all-cause mortality [4—6]. In one study of non-smokers, poor lung function was shown to be a better predictor of CVD and total mortality than established cardiovascular risk factors such as serum cholesterol [7].

Chronic obstructive pulmonary disease (COPD) is the third leading cause of death and affects 65 million worldwide, and the primary cause of COPD is tobacco smoke [8]. Its predictive capacity for cardiovascular disease incidence and mortality has been well documented in the past [9—11]. Because spirometry is the usual prognostic tool for diagnosing COPD and its severity, it serves as a common risk factor in evaluating the association of lung function with CHD and CVD. As early as 1983, the Framingham Study identified FVC as a prognostic indicator for CVD, in which different FVC indexes could vary the risk of CVD death by a three-to four-fold range [1]. Reduced FEV_1 has also been shown to predict cardiovascular morbidity and mortality in other studies [3].

Our study evaluates the association of reduced lung function and CVD or CHD events within the Rancho Bernardo prospective study of CVD, a well-established cohort of older predominantly Caucasian adults. No study has been published on the association of lung function and CVD in the Rancho Bernardo study cohort, and there are limited data on the long-term prognostic significance of lung function in population-based cohorts of older adults accounting for prevalent CVD.

Methods

Between 1972 and 1974, 6629 adults representing 82% of adult residents in Rancho Bernardo, a suburban Southern California community, participated in the baseline examination of the Rancho Bernardo Heart and Chronic Disease Study (RBS) [12]. Nonrespondents tended to have more CVD and history of smoking, but less hyperlipidemia and family history of CVD [13]. Residents were followed up in 1984—87 when 2479 participants attended a follow-up visit, and again in 1988—91 when new data on cardiovascular risk factors and pulmonary function (1988—91) were obtained. We studied 1548 participants from the Rancho Bernardo community-based cohort (mean age 73.6 $\pm$ 9.2 years, 42% males, primarily Caucasian) to assess pulmonary risk factors associated with CHD and CVD events. We also included demographic and diverse health-related information including body mass index, blood pressure, cholesterol, diabetes, physical exercise, smoking, and pulmonary function tests. Pulmonary function tests were performed using a water-sealed spirometer (Warren E. Collins, Eagle models, Braintree, MA) by a specially trained graduate student (Catherine Frette) who adhered to the 1987 American Thoracic Society guidelines [14] and performed from three to six tests to satisfy the ATS standards of acceptability and reproducibility. RBS participants were followed for a maximum of 22 years after spirometry. All participants gave written informed consent; the study was approved by the institutional review board of the University of California, San Diego.

Chronic obstructive pulmonary disease (COPD) risk groups were categorized as none (FEV_1/FVC $>$70%), mild (FEV_1/FVC $<$70%, FEV_1 $\geq$80%), and moderate/severe (FEV_1/FVC$<$ 70%, FEV_1 $<$80%) according to the GOLD (Global Initiative for Chronic Obstructive Pulmonary Disease) criteria. Moderate and severe categories were combined due to the number of participants within these groups.

Prevalent CVD was defined as physician-diagnosed myocardial infarction, coronary artery revascularization, congestive heart failure, stroke or transient ischemic attack, carotid surgery, peripheral arterial surgery, or physician-diagnosed intermittent claudication. Total (or incident) CHD and CVD refer to time of non-fatal or fatal CHD or CVD, whichever occurred first. Non-fatal CHD was defined as heart attack, coronary bypass, or angioplasty, while CVD additionally included stroke, TIA, and peripheral artery revascularization. Classification of incident CHD and CVD events were based on history, physician diagnosis, and/or ECG criteria with vital status confirmed by death certificates with underlying cause of death coded by a certified nosologist using ICD-9. Validation of self-reported heart attack (by chest pain, enzyme elevation, and ECG) was achieved for 72% of a subset for whom hospital records could be obtained.

All analyses were done using SAS version 9.1.3 (SAS institute, Cary, NC). Analysis of variance (ANOVA) was used to compare means between different COPD risk groups for continuous variables, and chi-squared test of proportions was used to compare proportions between the risk groups for categorical variables. We also calculated CHD and CVD mortality per 1000 person years associated with quartile of FVC, FEV_1, and ratio of FEV_1/FVC. Cox proportional hazards regression was used to determine the risk of total CHD or CVD from the standard CVD risk factors: age, sex, systolic blood pressure, diastolic blood pressure, body mass index, high density lipoprotein-cholesterol (HDL-C), low density lipoprotein (LDL-C), diabetes, smoking, exercise, COPD, and prevalent CVD, both adjusted and unadjusted for covariates. Additionally, we used Cox regression to assess